DEPARTMENT OF THE INTERIOR, CANADA

HON. THOMAS G. MURPHY, Minister H. H. ROWATT, Deputy Minister

GEODETIC SURVEY OF CANADA

NOEL J. OGILVIE, Director

ANNUAL REPORT

OF THE DIRECTOR

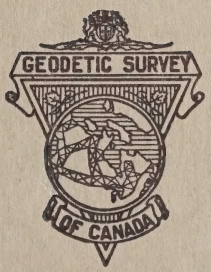
OF THE

GEODETIC SURVEY OF CANADA

FOR THE

FISCAL YEAR ENDING MARCH 31, 1932

1931/32



OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1933

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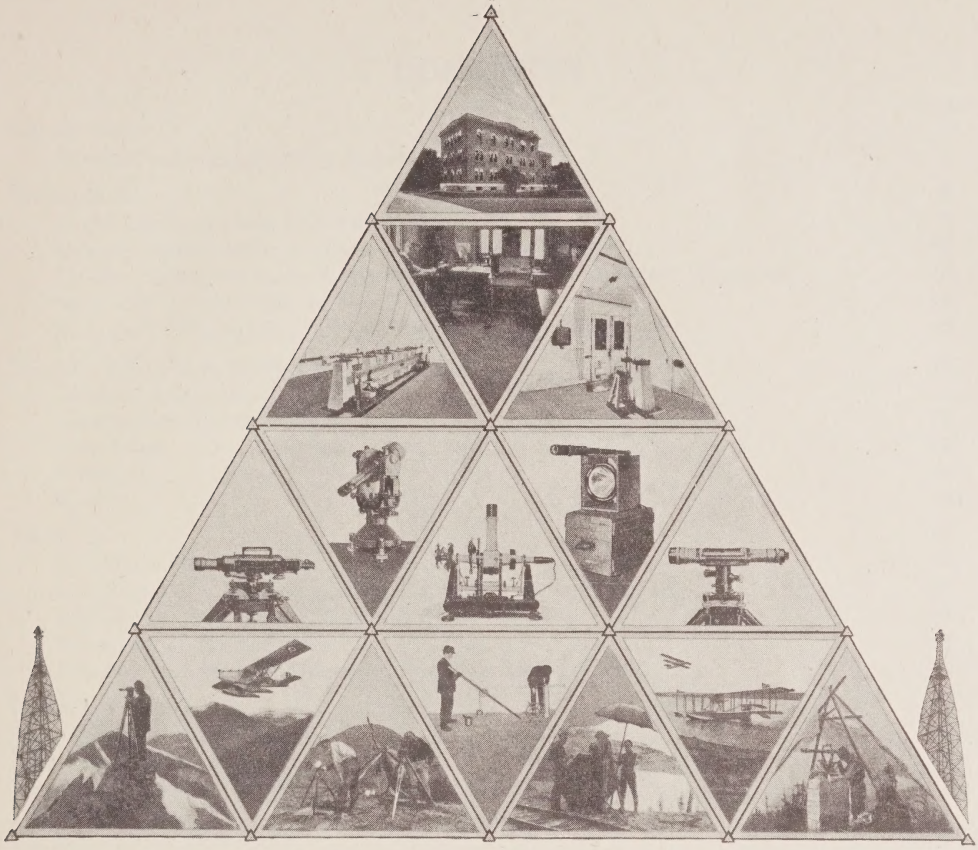

OPERATIONS OF THE GEODETIC SURVEY OF CANADA

Top—Geodetic Survey Building at Ottawa.

Second row, left to right—
North end of Standard building, showing five-metre apparatus.
Office of Precise Level Adjusting Division.
Fiducial point at south end of 50-metre comparator, in Standard building.

Third row, left to right—
Precise Level, U.S.C. & G.S. Pattern.
Latest Model Primary Triangulation Model theodolite.
Latest Model Astronomical Transit.
Electric Signal Lamp for Primary Triangulation.
Precise Level, Zeiss Model.

Bottom row, left to right—
Observing on Secondary Triangulation.
Photographic and Transport Hydroplane, Canadian model.
Sending instructions to light keepers by heliograph.
Setting rear end of tape in Baseline measurement.
Observing Precise Levels in the Yukon Territory.
A Transport Hydroplane at rest.
Observing Primary Triangulation.

On flanks—
Triangulation Tower near Chatham, Ont., with Lamp-stand extended 37 feet. Height of Lamp-stand: 147 feet.

56932—1½

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ILLUSTRATIONS

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THE GEODETIC SURVEY OF CANADA

ANNUAL REPORT OF THE DIRECTOR, NOEL J. OGILVIE

INTRODUCTION

The operations of the Geodetic Survey of Canada, Department of the Interior, during the fiscal year ended March 31, 1932, comprised primary triangulation, secondary triangulation, triangulation reconnaissance, precise levelling, secondary levelling, geodetic astronomy, triangulation base line measurement, isostasy, geodetic research, triangulation adjustment, precise levelling adjustment, testing new types of geodetic instruments, and the publication of geodetic survey data.

Field parties carried on geodetic operations in the provinces of British Columbia, Ontario, Quebec, and New Brunswick.

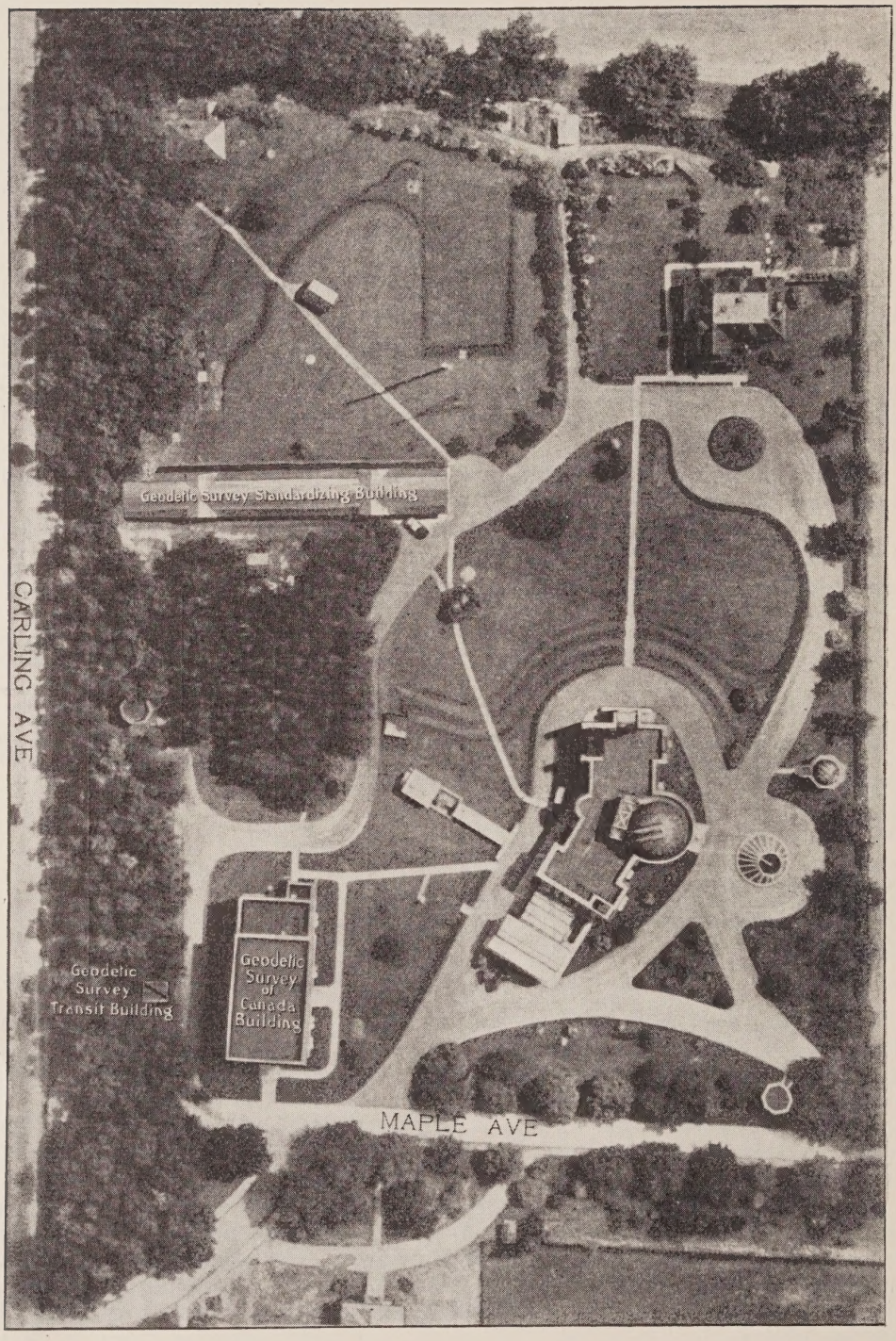
The following tabular statement shows the work of the seasons 1930-31, 1931-32, as well as the total accomplished to date:—

Field Operations	1930-31		1931-32		Total to Date	
	Axial length	Area	Axial length	Area	Axial length	Area
	miles	sq. miles	miles	sq. miles	miles	sq. miles
Primary triangulation	442	10,510	125	1,518	7,350	199,460
Secondary triangulation	.....	.....	50	1,350	1,023	6,955
Reconnaissance	1,430	28,611	552	19,289	.....	
Precise traverse	83	.....	.....	.....	505	
Precise levelling	189	.....	96	.....	24,559	
Secondary levelling	680	.....	217	.....	11,155	
	Number		Number		Number	
Standard bench marks	118	.....	41	.....	8,585	
Secondary bench marks	388	.....	121	.....	3,837	
Fundamental bench marks	24	.....	9	.....	119	
Geodetic astronomic stations	11	.....	3	.....	60	
Laplace stations	3	.....	2	.....	54	
Base lines	1	.....	1	.....	30	

Requests have been received by this Survey, as in previous years, from Federal and Provincial Government departments, municipalities, corporations, and the engineering and surveying public for the determination of geodetic latitudes, longitudes, and elevations above mean sea level. These were desired for the purpose of precise control data in engineering and surveying projects. On every occasion the most recently determined geodetic results have been promptly furnished.

Geodetically determined latitude and longitude with station descriptions included were printed and distributed for a number of permanently marked triangulation stations in the Maritime Provinces. The azimuth for each of a number of named lines at each station was also included. A manuscript covering similar results for a number of stations in southwestern Ontario was prepared for the printer.

The results of precise levelling on Vancouver island were printed and distributed.



Geodetic Survey of Canada Grounds.

Progress has been made in the development of a method by means of which triangulation results can be transferred from the Clarke Spheroid to the International Spheroid. This problem has necessitated the refinement of geodetic formulae to obtain the accuracy required by this Survey in lines of major length.

Laplace determinations were made at two of the triangulation stations of the Geodetic Survey of Canada. Latitude and longitude results of the order of accuracy required by this Survey for geodetic control were obtained on a number of frontiers.

Progress was made in the adjustment of the precise level net of Canada and adjustments of certain small level nets were carried out.

Aeroplane transportation was employed in certain areas where it was found to be more advantageous than other means of transport. Aeroplanes and pilots were provided through co-operation with the Royal Canadian Air Force.

Five publications of the Geodetic Survey of Canada were printed and are being distributed.

Material was prepared for the Fifth General Conference of the International Geodetic and Geophysical Union in 1933.

TRIANGULATION

During the season of 1931 triangulation operations were carried out on a much reduced scale compared with previous years. The progress of the field work is indicated in the table given on a succeeding page of this section. The weather was quite favourable for rapid progress and, considering the reduced scale of operations, satisfactory progress is reported.

Operations were carried on in five areas:—In northern Ontario aerial reconnaissance covered an area of 17,000 square miles in the district roughly bounded by lake Superior on the west and a north-and-south line through Sudbury on the east. In northern Quebec adjacent to the transcontinental line of the Canadian National Railways two groups of parties were engaged on angular measurements in an endeavour to complete a large loop of triangulation north of the St. Lawrence and Ottawa rivers. In the Gatineau River watershed north of Ottawa one group of parties was engaged on another section of the same loop. In a co-operative effort with the New Brunswick Forest Service 670 square miles of the northern interior area was covered with secondary triangulation. On the Belcher islands in Hudson bay a net of secondary triangulation was laid down as a basis for oblique and vertical aerial photography of the iron ore deposits on the islands.

Aerial Reconnaissance in Northern Ontario

Results Obtained.—Area covered by primary triangulation reconnaissance, 1,850 square miles; by secondary triangulation reconnaissance, 15,250 square miles; primary stations selected, 5; secondary, 54.

From September 18 to October 11, 1931, an engineer was engaged on aerial reconnaissance in northern Ontario with a cabin monoplane supplied by the Royal Canadian Air Force. The party consisted of a pilot, a mechanic and one engineer.

In February and March, 1931, an aerial reconnaissance for a primary net had been made in parts of the same area. This included a net roughly from White River to Sudbury following the main line of the Canadian Pacific Railway, with one branch from near Franz southward to within 30 miles of Sault Ste. Marie, and another branch from Woman River northeastward to join an older

net not far south of Timmins. In addition to this aerial work, ground reconnaissance had been done in 1930 for a net west from Sudbury to Sault Ste. Marie.

The scope of the operation conducted in September, 1931, was:—

1 To do sufficient primary reconnaissance around Sault Ste. Marie to connect the branch south from Franz with that west from Sudbury.

2 To extend the primary reconnaissance west from White River.

3 To fill in with secondary reconnaissance the area south of the primary net along the main line of the C.P.R. from Sudbury west to lake Superior.

4 To fill in with secondary reconnaissance the area north of the above primary net to a line about 20 miles north of the main line of the Canadian National Railways. This portion of the operation extended from Sudbury west as far as the Algoma Central Railway.

The whole of the area included in the program was covered in a total flying time of 56 hours, of which 8 hours was spent going to and returning from the area.

Progress statistics of this operation compared with other similar operations are given in the table below. The table shows that the stations were further apart on the average than was the case in previous operations. Otherwise the rate of progress was about the same as in other similar operations.

Operation	Area covered per flying hour	Axial distance along net per flying hour	Stations selected per flying hour
	sq. miles	miles	Number
Northern Ontario, winter 1931	223	11	1·7
Saskatchewan, April, 1931	218	12	1·2
Northern Ontario, September, 1931	354	11·5	1·4

The operation was conducted from two bases at Biscotasing and Oba Lake belonging to the Ontario Provincial Air Service, who kindly placed their camp facilities at the disposal of the party.

In the area south of the line of the Canadian National Railways (Sudbury to Longlac division) the topography is fairly rugged with plenty of lakes, an ideal country for aerial reconnaissance. North of the railway the country flattens out to the clay belt in which prominent hills are conspicuously absent and lakes scarce. As aerial reconnaissance in the latter area would have entailed very low and highly hazardous flying it was discontinued at the border of this flatter country.

In aerial reconnaissance operations in northern Ontario the maintenance of close contact with officers of the Forestry Branch of the Ontario Department of Lands and Forests has been found advantageous to both organizations. The Forestry Branch is gradually covering the whole area with a system of steel towers for forest fire detection and finds that the projected triangulation stations offer a valuable choice of hills as sites for these towers. By the time the angular measurements of the triangulation are undertaken fire towers will have been built on many of the stations, and the cost of preparing these stations for angular measurement will be greatly lessened. The advantages of aerial reconnaissance in this work are outstanding as it would have taken a ground party three or four seasons to cover the same area and its cost is substantially less than that of ground reconnaissance.


GEODETIC SURVEY OF CANADA
Noel J. Ogilvie, Director
TRIANGULATION
To March 31st. 1932
Observed
Reconnaissance
Statute Miles
100 0 100 200 300 400 500

Primary Triangulation in Northwestern Quebec

Results Obtained.—*Reconnaissance:* 11 secondary stations selected; area covered, 2,200 square miles; 8 primary stations visited and aerial reconnaissance checked. *Station Preparation:* 9 fire tower stations marked; 7 primary stations prepared, at three of which towers were built. *Angular Measurements:* 12 primary and 4 secondary stations completed.

Oskelaneo, on the transcontinental line of the Canadian National Railways, 34 miles west of Parent, was chosen as the base of operations. From this point operations were carried on astride the railway as far east as Vandry, a distance of approximately 113 miles. From the same base preliminary operations on a net of triangulation which extends northerly about 40 miles and then about 60 miles in a northwesterly direction, were carried on. The field season for all parties lasted from June 29 to September 22. Weather conditions for all classes of operations were much more satisfactory than during the previous season. Water levels were unusually low and difficulty was experienced in navigating the creeks.

Reconnaissance.—For part of the season a reconnaissance party carried on ground checking of the aerial reconnaissance done at the end of the previous season. Eight stations were visited and their locations checked. These stations are from 1 to 8 miles from the nearest lake on which aeroplanes could land, so that routes to the stations had to be located. One secondary station was located and occupied as a control station for aerial photography. An aerial reconnaissance was made for secondary triangulation over an area northeast of Oskelaneo, covering the easterly part of the Gouin storage reservoir. An area of 2,200 square miles was covered and 10 stations were selected.

Station preparation.—The station preparation party at the opening of the season established points directly beneath the centres of 9 fire towers belonging to the St. Maurice Fire Protective Association, located on the eastern end of the season's work on both sides of the railway between Flamand and Casey railway stations. Bronze posts were used to mark the centres with the exception of one tower southeast of Flamand where a copper tablet was set in a small concrete monument. This tablet was set directly over another tablet set in the rock. These fire towers had been tied in to the triangulation during the previous season.

After completing this work the party returned by train to Oskelaneo and started work preparing stations on the new net extending north from the line Provancher-Greening. Seven stations were fully prepared for observing. The towers built at four stations ranged from 20 to 35 feet in height. At Obiduan station as the fire tower of the St. Maurice Fire Protective Association was available it was only necessary to build a tripod inside it. Two of the points were prepared as ground stations.

Angular observations.—One observing party was engaged on angular measurements during the season. In all 12 stations were occupied, 8 of which were new stations and 4 were stations that had been only partially completed the previous season; 2 stations on this season's work were occupied twice; 3 secondary stations were established by daylight observations and another secondary station by means of lamp signals at night. This latter station was an important control point for aerial photography. The section of the triangulation covered by the observing party extended east from Oskelaneo to Vandry , a distance of about 113 miles. The area covered followed the railway which afforded a convenient point of departure for reaching stations that were not accessible by aeroplane.

Type of Hydroplane used for Triangulation Reconnaissance.

Aerial operations.—Weather conditions were much more satisfactory for flying activities than they were during the 1930 season. Excellent service was provided by a Royal Canadian Air Force photographic detachment. A total of 288 hours was flown on transportation of parties from point to point. The total of flying hours for this operation was only about 50 per cent of that for 1930, this reduction being due principally to the short season for geodetic operations, the location of the air base in the centre of the working area, and to the proportion of geodetic stations not accessible by plane.

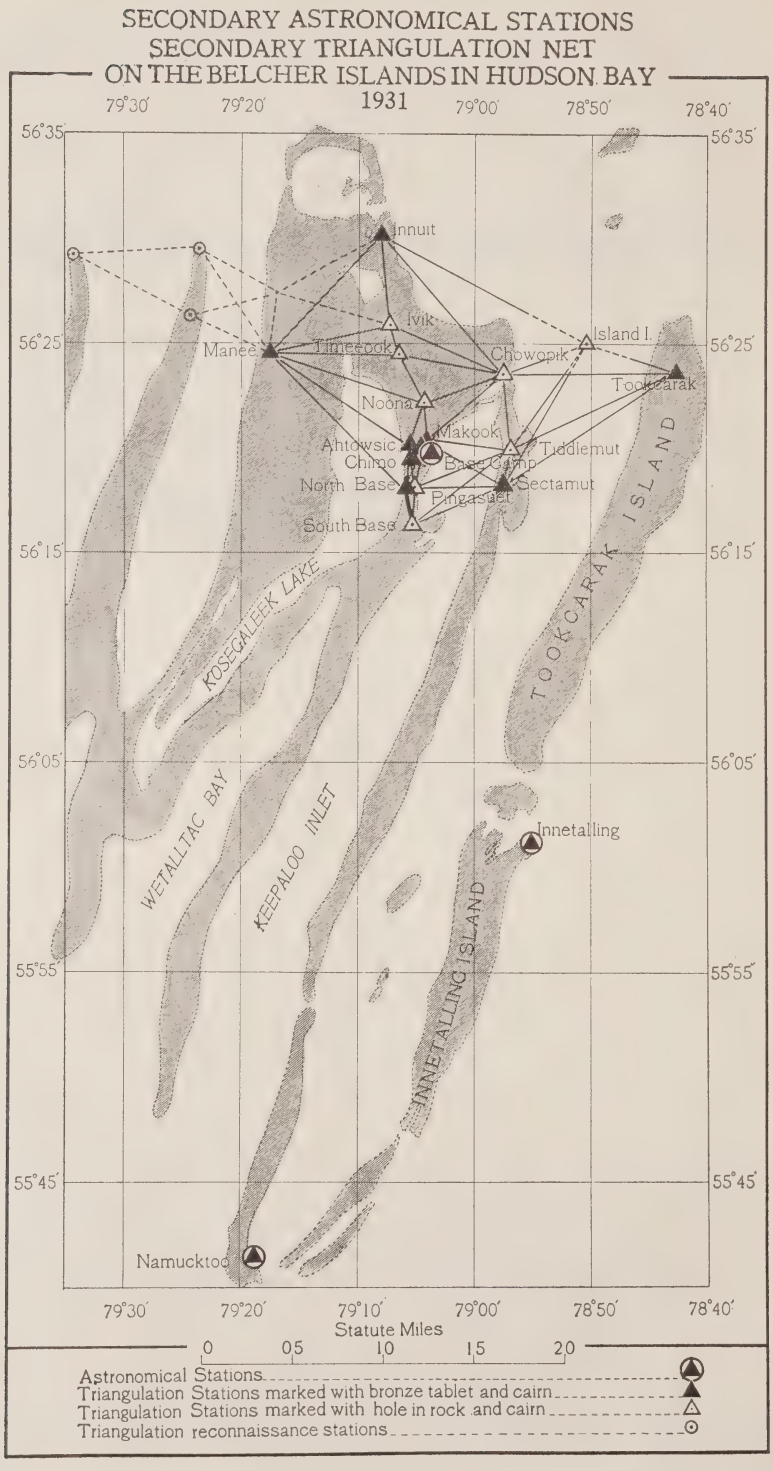
Primary Triangulation in Western Quebec and Gatineau River Watershed

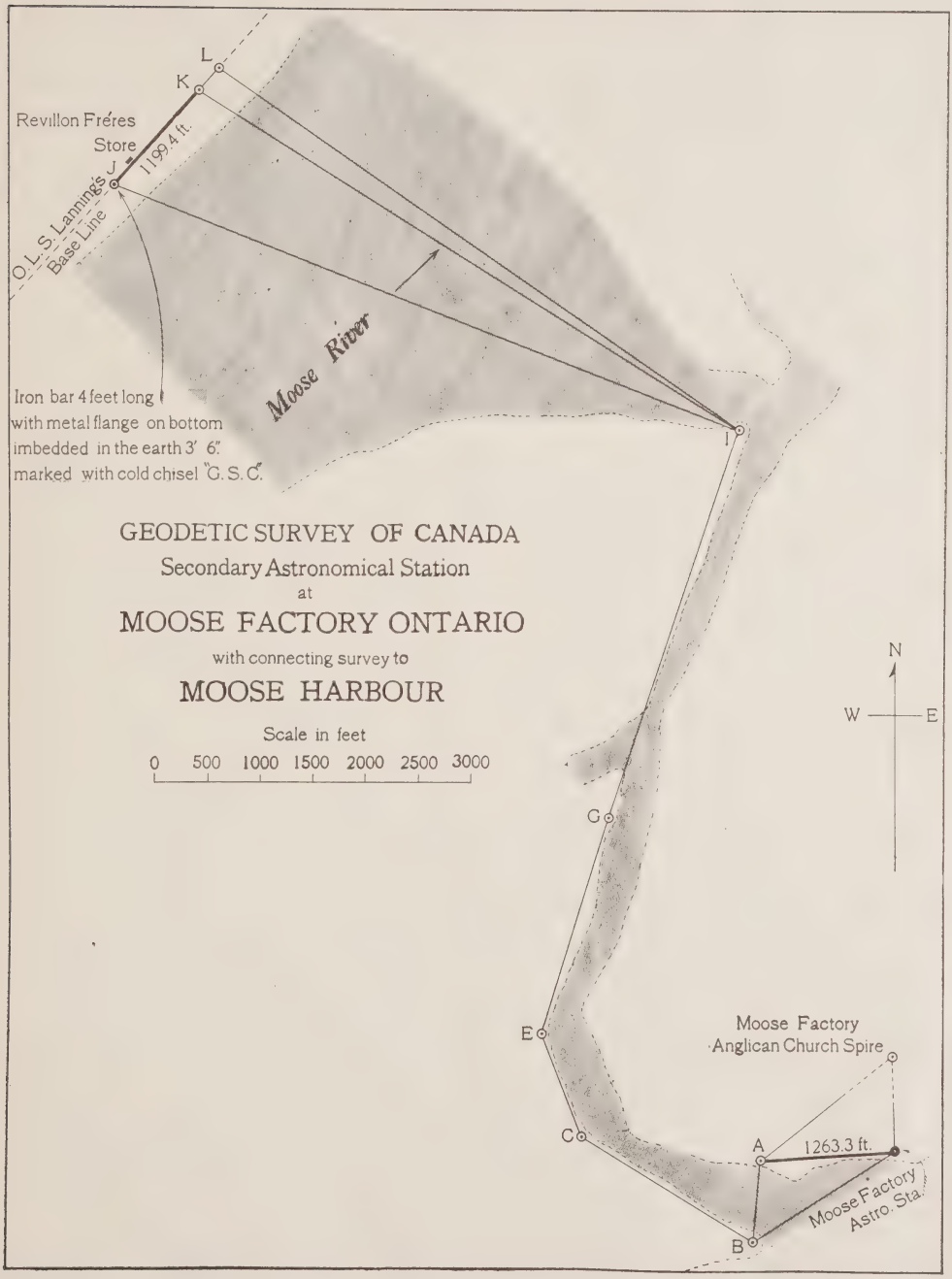
Results Obtained.—*Western Quebec,* stations occupied, 11, towers built, 2. *Gatineau River watershed,* stations occupied, 9; one tower erected; one monument rebuilt.

During June and July a small party comprising two engineers, two light-keepers and one labourer was engaged in measuring the angles of a portion of a net of triangulation extending westward from Senneterre to Amos along the Canadian National railway. This net had previously been observed under very unfavourable weather conditions and was found to be of a lower grade of precision than was required for this class of work. Very good weather prevailed during June and July, and the small party completed a fairly large program with satisfactory results. In all eleven stations were occupied and two 20-foot towers were built. The majority of the stations required at least two nights' work for confirmation of results. When this operation was completed the party moved to Ottawa and then proceeded to the Gatineau River watershed, where similar checking of angles was carried on, as well as observations on new lines and one new station. Eight stations were re-occupied and one new station was established with satisfactory results.

Secondary Triangulation in New Brunswick

Results Obtained.—Two tripods erected; 5 stations occupied; geographic positions of 3 fire towers determined; area covered, 670 square miles.


SECONDARY ASTRONOMICAL STATIONS
SECONDARY TRIANGULATION NET
ON THE BELCHER ISLANDS IN HUDSON BAY
1931
79°30′
79°20′
79°10′
79°00′
78°50′
78°40′
56°35′
56°25′
56°15′
56°05′
55°55′
55°45′
Innuit
Ivik
Manee
Timeecook
Chowopik
Island I.
Tookcarak
Noona
Makook
Ahtowsic
Chimo
Base Camp
Tiddlemut
North Base
Sectamut
Pingasuet
South Base
KOSEGALEEK LAKE
TOOKCARAK ISLAND
WETALLTAC BAY
KEEPALOO INLET
INNETALLING ISLAND
Innetalling
Namucktoo
Statute Miles
0 05 10 15 20
Astronomical Stations
Triangulation Stations marked with bronze tablet and cairn
Triangulation Stations marked with hole in rock and cairn
Triangulation reconnaissance stations


L
K
Revillon Frères
Store
J
1199.4 ft.
O.L.S. Lannings
Base Line
Moose River
Iron bar 4 feet long
with metal flange on bottom
imbedded in the earth 3' 6"
marked with cold chisel "G.S.C."
I
GEODETIC SURVEY OF CANADA
Secondary Astronomical Station
at
MOOSE FACTORY ONTARIO
with connecting survey to
MOOSE HARBOUR
Scale in feet
0 500 1000 1500 2000 2500 3000
N
W
E
G
E
C
Moose Factory
Anglican Church Spire
A
1263.3 ft.
Moose Factory
Astro. Sta.
B

With the co-operation of the New Brunswick Forest Service an area in the north central part of the province was covered by secondary triangulation. This central area is surrounded by primary triangulation nets and the operation consisted in locating the positions of a number of fire lookout towers scattered over the area enclosed by the primary nets. Observations were made in daytime on the circular cabins on the tops of these towers from tripods built inside those chosen as suitable observing stations. About one-third of the area required to be so covered was completed during the season. It was determined that mount Kagoot is considerably lower than mount Carleton.

Secondary Triangulation, Belcher Islands, Hudson Bay

Results Obtained.—Stations completed, 18. Stations selected but not completed, 4. Area covered, 400 square miles.

In connection with investigations of the iron ore deposits in the Belcher islands near the east coast of Hudson bay, an aerial photographic operation was carried out during the season of 1931 for the production of an accurate map of the area. A geodetic party accompanied the aerial photographic detachment and established a number of control stations by means of astronomical positions (latitude and longitude).

Secondary triangulation on this datum was found to be more suitable to weather conditions and to aerial transportation than isolated astronomical stations, and the geodetic party confined its activities to this form of control during the latter part of a short season. About one-fifth of the total area of Belcher Islands group was covered by a secondary net comprising 18 stations. Owing to rough weather conditions the work had to be closed down on September 5. The average length of the main triangulation lines was 7 miles. Signals consisted of a rock cairn erected over a bronze tablet cemented into solid rock.

GEODETIC ASTRONOMY, ISOSTASY AND BASE LINES

Geodetic Astronomy

Laplace observations were made at two of the triangulation stations of the Geodetic Survey of Canada, namely, Douville in the Northern Quebec triangulation net, and Azilda in the Sudbury net. In addition to the longitude and azimuth observations necessary to establish the Laplace equation, observations were made to determine the astronomical latitudes.

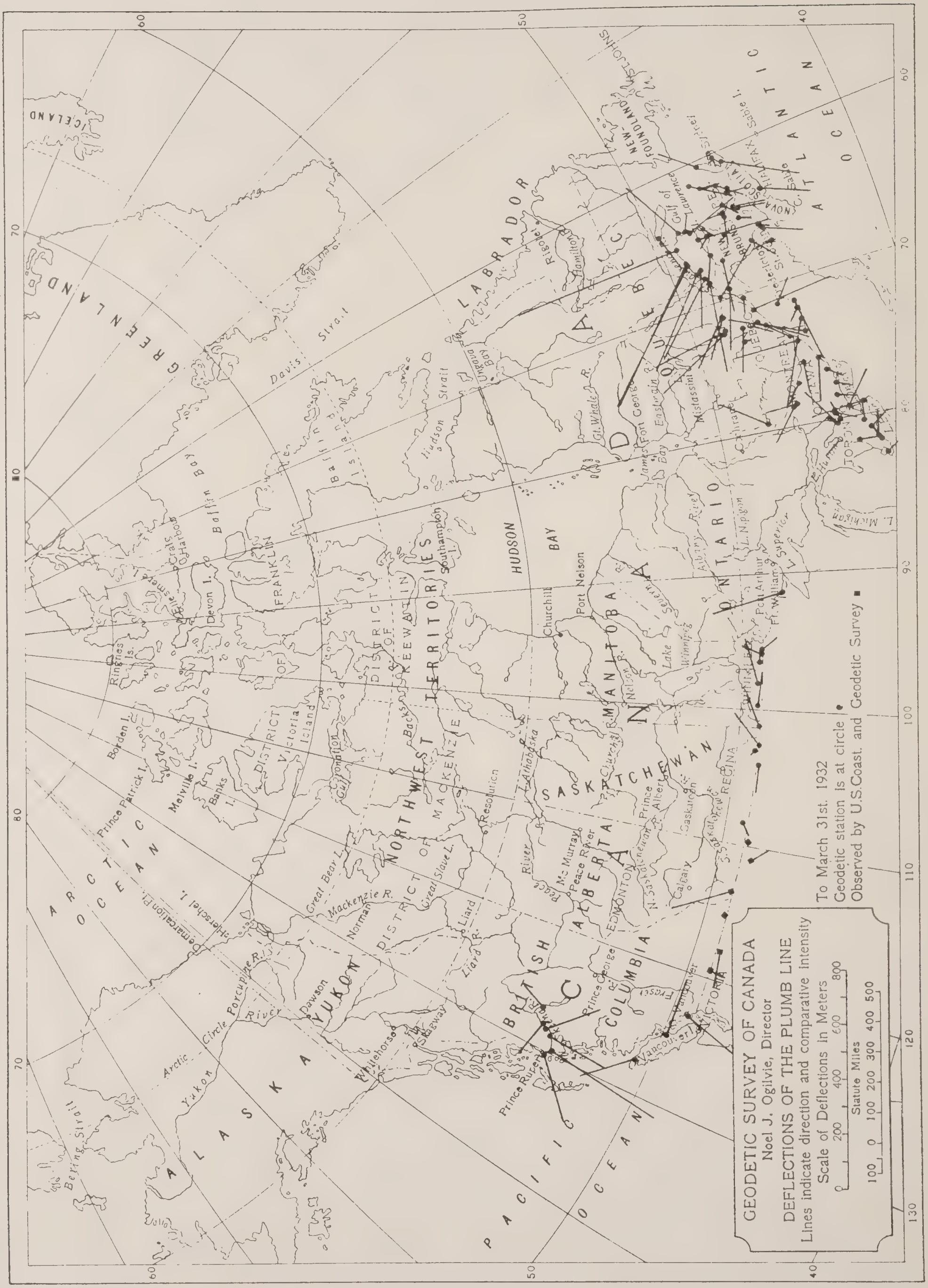
The longitudes were determined by the wireless method. Time signals broadcast either from Annapolis or Arlington were compared with the sidereal chronometer at the observing station by the coincidence method. With several time-signal broadcasts daily, the field observer is enabled to determine the rate of his sidereal observing chronometer with a great degree of accuracy, and also to make two or three longitude determinations in a single night.

At Douville the azimuth of the line Douville to Eshawahni, and at Azilda, that of Azilda to Treadwell were observed. The method used in azimuth observations is the micrometer direction method and the final value is the mean of observations made in thirty-two positions of the horizontal circle.

Geographical Determinations

An observing party to establish geodetic control for secondary triangulation was sent to the Belcher islands in Hudson bay. The longitudes and latitudes of three stations were determined with the order of accuracy required by the Geodetic Survey of Canada for secondary control, and these stations were


GEODETIC SURVEY OF CANADA
Noel J. Ogilvie, Director
OBSERVED ASTRONOMICAL POINTS.
To March 31st 1932
Statute Miles
100 0 100 200 300 400 500
GREENLAND
ICELAND
LABRADOR
NEWFOUNDLAND
ATLANTIC OCEAN
ARCTIC OCEAN
PACIFIC OCEAN
HUDSON BAY
ONTARIO
MANITOBA
SASKATCHEWAN
ALBERTA
BRITISH COLUMBIA
NORTHWEST TERRITORIES
YUKON
ALASKA


GEODETIC SURVEY OF CANADA
Noel J. Ogilvie, Director
DEFLECTIONS OF THE PLUMB LINE
Lines indicate direction and comparative intensity
Scale of Deflections in Meters
Statute Miles
To March 31st. 1932
Geodetic station is at circle
Observed by U.S.Coast and Geodetic Survey

connected by triangulation to twelve points on the southern half of the Belcher group. The corners of the mining claims previously surveyed were tied to the triangulation established by the Geodetic Survey.

Two other longitude and latitude stations, one at Whale River on the east coast of Hudson bay and the other at Moosonee (formerly called Moose Harbour), were also observed for secondary control. At Moosonee a small net of triangulation was laid down in the vicinity of the Harbour, and the more prominent landmarks were connected.

Base Lines

One base line in the Sudbury triangulation net was measured in 1931. This base is 6·309 miles long and lies between the Azilda and Treadwell geodetic triangulation stations.

Standards

The invar base line tapes were standardized before and after measuring the Azilda base line. It is very satisfactory to know that these base line tapes have apparently reached a stage where their lengths will suffer a minimum change. This or a less favourable condition can, however, be attested only by standardizing them in the regular way mentioned.

Isostasy

During the past year the work on isostasy has been confined almost entirely to office computations. There is urgent need for observations at about a dozen stations in Nova Scotia and New Brunswick. With the data so supplied all the material of stations from Ontario east to the Atlantic coast could be adjusted, and a determination of the isostatic condition underlying that district could be obtained.

LEVELLING

Early in the fiscal year arrangements were made for the amalgamation of the precise level system of the Department of Public Works with the level system of the Geodetic Survey of Canada. Since 1882 the Department of Public Works in connection with harbour improvements and aids to navigation, has been developing a precise level system along the Great lakes and the St. Lawrence river. When this amalgamation is completed it will mean that all precise levelling in Canada will be correlated into one national net and that all precise level bench marks will be referred to one standard datum.

During the year the preparation of the manuscript *Precise Levelling on Vancouver Island* was completed. This publication was printed as Publication No. 38 of the Geodetic Survey of Canada.

Two regular levelling parties and one special party were in the field in the summer of 1931, the regular parties operating in the provinces of Ontario and British Columbia. The special party was engaged in the establishment of fundamental bench marks in certain cities and towns in southwestern Ontario.

Levelling in the Province of Ontario

The operations of the regular levelling party were a continuation of the work carried out in 1929 and 1930 and extended levelling control into the area between lake Simcoe and lake Ontario. A line of levels was run along Provincial Highway No. 11 from Orillia to the outskirts of Toronto, thence turning east to close at Agincourt. Additional lines extended from Virginia to Newmarket, via Sutton and Keswick, and from Sharon to Uxbridge and Port Perry. One


GEODETIC SURVEY OF CANADA
Noel J. Ogilvie, Director
PRECISE LEVELLING
To March 31st. 1932
Statute Miles
100 0 100 200 300 400 500

fundamental bench mark was built by this party at Barrie, while the special party established eight of these, namely, at Beamsville, Carleton Place, Fort Erie, Grimsby, Ingersoll, Niagara-on-the-Lake, Niagara Falls, and Oakville.

Levelling in the Province of Quebec

The only levelling carried out in the province of Quebec during the fiscal year was in the Beauharnois district, where 41 miles of additional levelling was done at the request of the Beauharnois Light, Heat and Power Company. This was a continuation and rounding out of the work done in 1929 in providing levelling control in the power canal area. As formerly, the cost of the field work was borne by the company.

Levelling in the Province of British Columbia

The receipt of a request from the United States Coast and Geodetic Survey for co-operation necessitated the running of two branches from the main line of levels extending across the southern portion of the province from Nelson to Vancouver. One of these branches ran from Cascade, British Columbia, to the international boundary near Laurier, Washington, a distance of only two or three miles; the other, some twenty-nine miles in length, followed the Great Northern Railway line from Midway, British Columbia, to the boundary, at a point between Bridesville, British Columbia, and Molson, Washington. These two lines, being tied in with the United States Survey's lines of levels from the south, will result in harmonizing the combined levels in this district.

On the completion of the above work, levels were run through the valley of the Upper and Lower Arrow lakes from Nakusp to Needles and Edgewood and, later on, between Nelson and Balfour via the north shore of the West Arm of Kootenay lake. Bench marks and gauges of the Department of Public Works and of the Dominion Water Power and Hydrometric Bureau were tied in by means of these levels and placed on the Geodetic Survey datum.

Inspection of Bench Marks

Due to the transfer of the precise level system of the Department of Public Works in Eastern Canada to this Survey in the spring of 1931, between four and five thousand additional miles of levelling were brought under the jurisdiction of the Geodetic Survey. As most of this levelling dates back to the earlier years of the present century, it was deemed necessary to carry out an inspection of all the bench marks in order to note their condition and delete from the records all those which had been destroyed, also to revise the descriptions of the existing bench marks to allow for the changes brought about with the passing of years.

Some 700 bench marks, in the region of lake Ontario and lake Erie, were included in the inspection, the district covered extending from Prescott to Toronto and through the Niagara district as far west as Chatham, Ontario. It was found that about 13 per cent of the bench marks originally established had been destroyed.

The following tables give the mileage of levelling run in 1931, a summary by provinces, and a general statement showing the total run from the beginning of operations to date.

DETAILED STATEMENT OF LEVELLING RUN IN 1931-32

Precise Levelling	Miles	Secondary Levelling	Miles
Utopia to Barrie, Ont.	10·6	Orillia to Agincourt, Ont.	81·8
St. Catharines to Niagara-on-the-Lake, Ont.	13·1	Virginia to Newmarket, Ont.	29·1
Beauharnois district, Que.	40·6	Sharon to Port Perry, Ont.	27·6
Midway to Bridesville, B.C.	28·7	Nakusp to Edgewood, B.C.	45·0
Cascade, B.C., to Laurier, Wash.	2·5	Balfour to Nelson, B.C.	25·1
		Kootenay Landing gauge connection	4·1
		Creston Ferry gauge connection	4·1
	95·5		216·8

Summary by Provinces for 1931-32

Precise Levelling	Miles	Bench marks	Secondary Levelling	Miles	Bench marks
Quebec	41	18	Ontario	139	77
Ontario	24	18	British Columbia	78	44
British Columbia	31	14			
	96	50		217	121

The mileage of precise and secondary levelling at the end of the fiscal year is as follows:—

—	Precise Levelling			Secondary Levelling		
	Prior to 1931	1931	Total	Prior to 1931	1931	Total
Nova Scotia	729	.....	729	.....	.....	.....
New Brunswick	1,096	.....	1,096	.....	.....	.....
Quebec	3,377	41	3,418	640	.....	640
Ontario	5,842	24	5,866	995	139	1,134
Manitoba	2,263	.....	2,263	368	.....	368
Saskatchewan	4,113	.....	4,113	5,098	.....	5,098
Alberta	2,866	.....	2,866	3,795	.....	3,795
British Columbia	3,624	31	3,655	42	78	120
Yukon Territory	458	.....	458	.....	.....	.....
Minnesota (U.S.A.)	89	.....	89	.....	.....	.....
Vermont (U.S.A.)	6	.....	6	.....	.....	.....
	24,463	96	24,559	10,938	217	11,155

Of the 96 miles of precise levelling done in 1931, 11 miles were on the Canadian National railway, 29 on the Great Northern, and the remaining 56 miles on roads.

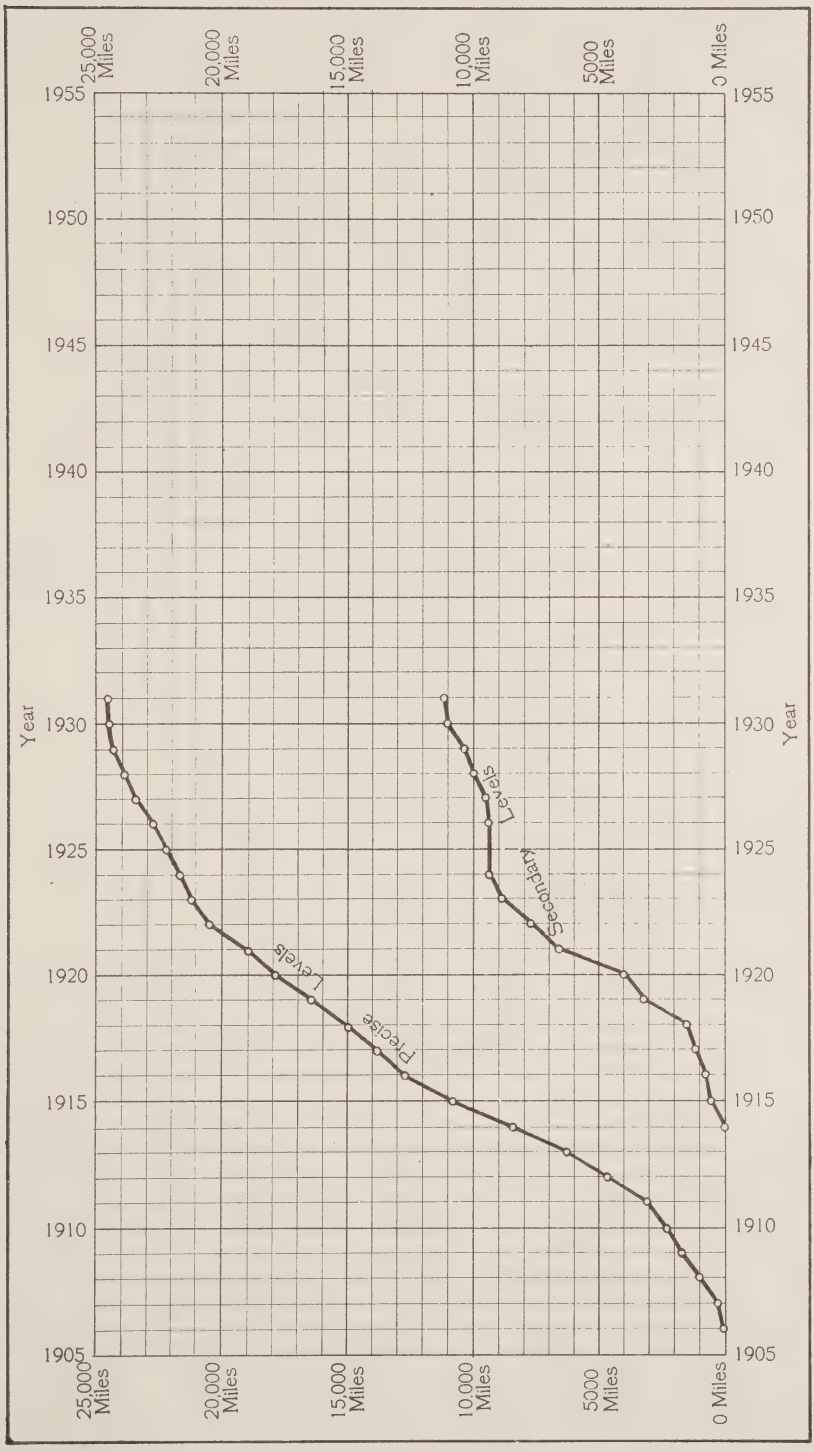
The numbers of bench marks established are as follows:—

Precise levelling: Established prior to 1931, 8,544; in 1931, 50; total, 8,594.

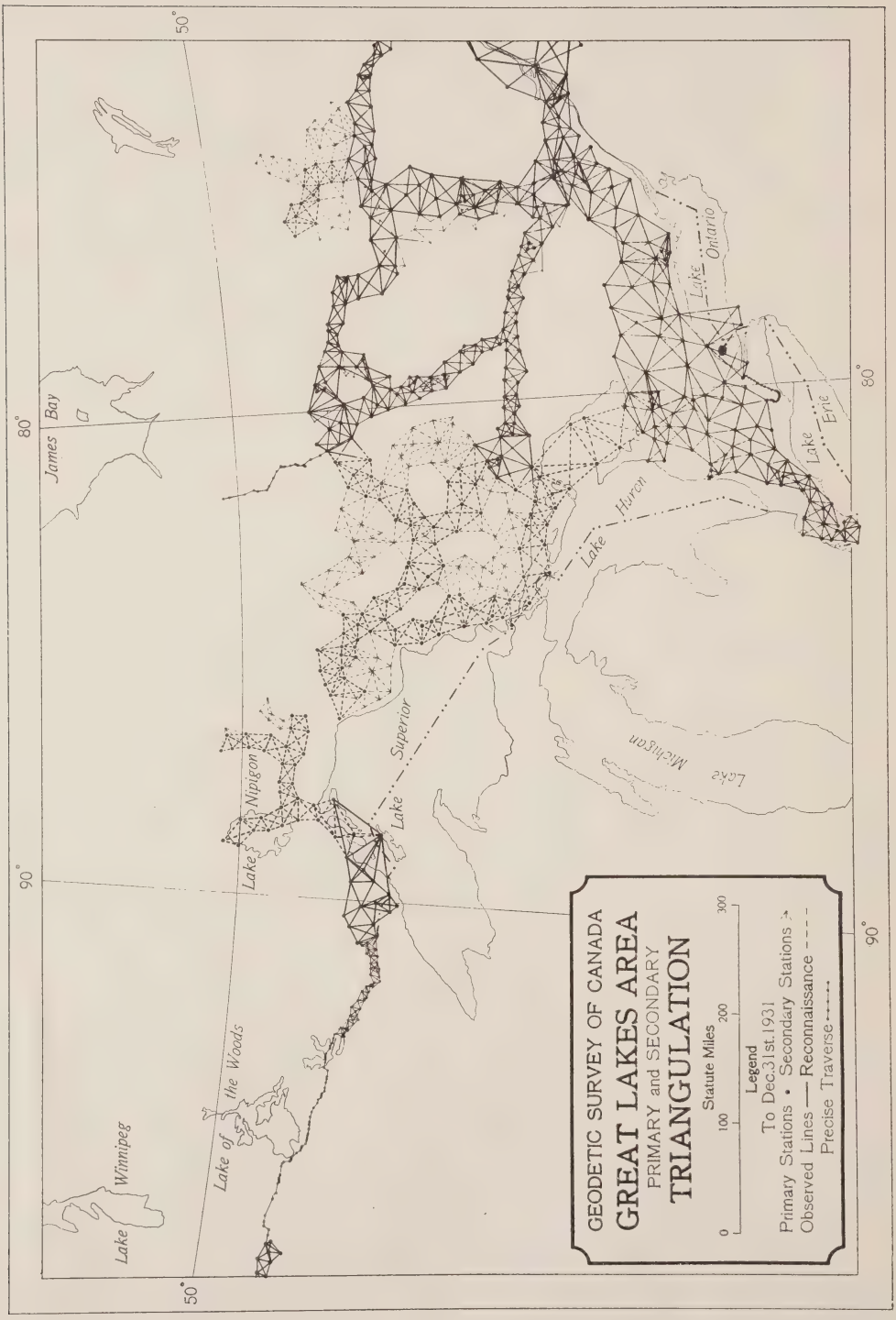
Secondary levelling: Established prior to 1931, 3,716; in 1931, 121; total, 3,837.

GEODETIC RESEARCH

The chief problem which has been studied during the past year is that of transferring triangulation results from the Clarke to the International Spheroid.



Precise and Secondary Levelling, 1931


GEODETIC SURVEY OF CANADA
GREAT LAKES AREA
PRIMARY and SECONDARY
TRIANGULATION
Statute Miles
0
100
200
300
Legend
To Dec. 31st. 1931
Primary Stations • Secondary Stations
Observed Lines —— Reconnaissance - - - -
Precise Traverse ·····
Lake Winnipeg
Lake of the Woods
Lake Nipigon
Lake Superior
James Bay
Lake Huron
Lake Michigan
Lake Ontario
Lake Erie
50°
80°
90°

Former investigations in connection with this problem have shown that the operation of adjusting the triangulation observations will not have to be repeated, and that the lengths of the individual lines will remain unchanged. The problem then resolves itself into finding a suitable means whereby the actual co-ordinates of the triangulation stations and the mutual azimuths of the lines may be changed to the new spheroid with a minimum of labour. It has recently been ascertained that the formulae derived in this office must be further refined in order that the required accuracy may be obtained over lines of major length.

TRIANGULATION ADJUSTMENT

The work of this division is largely a continuation of the publication program outlined in the last report. The manuscripts for the publication covering triangulation results in southwestern Ontario, from Belleville, westerly, to Collingwood and Windsor, is now completely prepared, and it is hoped that it will be available for distribution in the near future.

The first edition of Publication No. 2, covering primary triangulation in Quebec and Ontario from Montreal, westerly, to Belleville, is now exhausted and a revised edition of it, with enlargements covering the newer work in this area, is now being prepared for publication.

The need for a single-volume publication of geodetic tables containing all those in general use in this office is urgent. To supply this demand, tables are now being compiled and the work is progressing satisfactorily.

In accordance with the adoption of the North American Datum arrangements were made for a comprehensive adjustment affecting primary triangulation results easterly from the 98th meridian both in Canada and the United States. The purpose of this general solution of results is to obtain a more accurate placement of the triangulation framework of the Geodetic Survey of Canada and the Coast and Geodetic Survey of the United States. The result will be of great service to this Survey, as many anomalies now existing at the international boundary are expected to be smoothed out. As this Survey is dependent on the values of the geodetic co-ordinates, made available at the boundary by the United States Coast and Geodetic Survey, for the extension of the calculations on the uniform basis of the North American datum, it is quite evident that this co-operation is a step forward in Canadian practice.

The revision, consequent upon newer values of our initial points along the international boundary being issued, is not to be undertaken until the present framework lying within Canadian territory has become considerably enlarged. In fact, it seems desirable not to undertake the work of revision until such time as the Eastern work is joined to that of the Western work in the region bordering on the 98th meridian.

Various demands for geographic positions from other government bureaus, engineering corporations and private individuals have been received and the information compiled and forwarded. These demands are constantly increasing in number and reflect an increasing use of geodetic work as control in other survey operations.

LEVELLING ADJUSTMENTS

The 1931 Adjustment contains 94 conditions in which the following tidal stations are held:—Halifax, Yarmouth, and Father Point in the East; and Vancouver, Prince Rupert, and Squamish in the West. As Squamish is not as reliable as the other five tidal stations, it will be dropped as a held point in future adjustments.

Besides this adjustment of the primary net, several adjustments of small nets of secondary levelling and Public Works levelling have been carried out. Lines included in these adjustments were secondary lines, 137-s, Callander to Orillia; 153-s, Bracebridge to Huntsville; 154-s, Orillia to Dorset; 155-s, Kinmount to Sunderland; 156-s, Talbot to Bowmanville; 157-s, Orillia to Agincourt; 158-s, Cannington to Newmarket; 159-s, Sharon to Port Perry, and the Public Works line from Toronto to North Bay.

In these latter adjustments, all lines are adjusted to the published elevations of junction points of the Primary Net, and weighting is proportional to the inverse of the length of the lines.

MECHANICAL PHYSICS

This division consists of four sections. Research work in connection with survey methods and survey instruments is carried on. When a new method necessitates a new instrument, it is designed and construction drawings are made. When an appropriation is available the new instrument is constructed and tested.

Material descriptive of the work of the Geodetic Survey was collected, written up and illustrated to be used in geodesy classes in response to a request from Queen's University. Progress was made in the writing of "A Quarter Century History of the Geodetic Survey of Canada."

Under the section of drafting and photography, 47 drawings for coloured maps, line-cut maps, nomograph charts, etc., illustrating publications of the Geodetic Survey of Canada, were made; 10 zinc photolithograph sheets were stippled; 20 instruments were engraved; 1,074 forms were lettered; copies of 126 maps and 2,515 photographic copies of office work were ordered. A design with drawing, for a new field chronograph, smaller and lighter than the present type of instrument, was made.

Under the section of instruments, 102 pieces of instrumental equipment, including electric time clocks and signal lamps were tested; minor repairs were made when necessary and 34 major repairs were ordered; field equipment including 107 instrument boxes, was overhauled and recorded.

The section of wood-working completed 85 different pieces of work, seventy-five per cent of them being the construction of new tripods, level rods, instrument cases, etc.

PUBLICATIONS

The following publications of the Geodetic Survey of Canada were printed for distribution by means of an annually revised mailing list: No. 32, *Triangulation in New Brunswick and Prince Edward Island;* No. 33, *Triangulation in Eastern Nova Scotia, Magdalen Islands and Southwestern Newfoundland;* No. 38, *Precise Levelling on Vancouver Island;* No. 5 (revised edition), *Field Instructions to Geodetic Engineers in Charge of Direction Measurement on Primary Triangulation; Annual Report of the Director of the Geodetic Survey of Canada for the Fiscal Year ended March 31, 1931.* A number of publications were prepared for the printer. Articles on the Geodetic Survey of Canada were printed and the text of a number of broadcast talks referring to this Survey were printed in Canadian newspapers.

LOCALITY OF FIELD OPERATIONS OF THE GEODETIC SURVEY OF CANADA DURING THE FISCAL YEAR ENDED MARCH 31, 1932

Triangulation

Northwest Territories	Secondary Triangulation in Belcher Islands.
Northern Ontario	Primary Triangulation—aerial reconnaissance.
Northern Quebec	Primary Triangulation—aerial reconnaissance angular measurements, station preparation and tower building.
New Brunswick	Secondary Triangulation.

Geodetic Astronomy, Isostasy and Base Lines

Ontario and Quebec	Laplace Stations.
Hudson Bay, Belcher Islands	Astronomical Points.
Ontario	Base Line Measurements.

Levelling

British Columbia	Precise and Secondary Levelling.
Ontario	Construction of Fundamental Bench Marks. Precise and Secondary Levelling.
Quebec	Precise Levelling.

PUBLICATIONS OF THE GEODETIC SURVEY OF CANADA

Publication No.

2—Adjustment of Geodetic Triangulation in the Provinces of Ontario and Quebec, 10 cents.

3—Determination of the Lengths of Invar Base Line Tapes from Standard Nickel Bar No. 10239, 10 cents.

5—Field instructions to Geodetic Engineers in charge of Direction Measurement on Primary Triangulation, $1.
Instructions to Lightkeepers; Use of Electric Signal Lamps being an Appendix (No. 4) to Publication No. 5, 10 cents.

7—Geodetic Position Evaluation, 10 cents.

8—Field Instructions for Precise Levelling, 10 cents.

10—Instructions for Building Triangulation Towers, 10 cents.

11—Geodesy, 50 cents.

12—Mathematical Statistics of the Geodetic Survey of London, Ont. (Distributed at London, Ont.).

14—Levelling, Co-ordination of Elevations of Bench Marks in the City of Calgary, Alberta, 10 cents.

15—Levelling. Bench Marks Established along Meridians, Base Lines and Township Outlines in Saskatchewan, 10 cents.

16—Levelling. Precise Levelling in Nova Scotia, New Brunswick and Prince Edward Island, 10 cents.

17—Levelling. Precise Levelling in Quebec South of St. Lawrence River, 10 cents.

18—Levelling. Precise Levelling in Quebec North of St. Lawrence River, 10 cents.

19—Levelling. Precise Levelling in Ontario South of Parry Sound, 10 cents.

20—Levelling. Precise Levelling in Ontario North of Parry Sound, 10 cents.

PUBLICATIONS OF THE GEODETIC SURVEY OF CANADA—*Concluded*

Publication No.

21—Levelling. Precise Levelling in Manitoba, 10 cents.

22—Levelling. Precise Levelling in Saskatchewan, 10 cents.

23—Levelling. Precise Levelling in Alberta, 10 cents.

24—Levelling. Precise Levelling in British Columbia, 10 cents.

25—The Conversion of Latitudes and Departures of a Traverse to Geodetic Differences of Latitude and Longitude, 25 cents.

26—The Simultaneous Adjustment of Precise Traverses and Triangulation Nets, 25 cents.

27—The Differential Adjustment of Observations, 25 cents.

28—Adjustment of Precise Level Net of Canada, 1928, 10 cents.

30—Triangulation in New Brunswick and Nova Scotia, 50 cents.

31—Triangulation in Quebec and New Brunswick, 50 cents.

32—Triangulation in New Brunswick and Prince Edward Island, 50 cents.

33—Triangulation in Eastern Nova Scotia, Magdalen Islands and Southwestern Newfoundland, 50 cents.

35—Triangulation Closure in the Maritime Provinces, 50 cents.

36—Deflection of the Plumb Line in Canada, 25 cents.

Report of the Operations of the Geodetic Survey of Canada, April, 1912, to March, 1922, prepared by the Director for the First General Assembly of the International Geodetic and Geophysical Union held at Rome, 1922. (Bound with the Reports of the Section of Geodesy of the International Geodetic and Geophysical Union, 1922), 10 cents.

Report of the Operations of the Geodetic Survey of Canada, April, 1922, to March, 1924, prepared by the Director for the Second General Assembly of the International Geodetic and Geophysical Union held at Madrid, 1924, 10 cents.

Report of the Operations of the Geodetic Survey of Canada, April, 1924, to December, 1926, prepared by the Director for the Third General Assembly of the International Geodetic and Geophysical Union held at Prague, 1927, 10 cents.

37—Geodetic Operations in Canada—January 1, 1927, to December 31, 1929. Reports of the Section of Geodesy—The International Geodetic and Geophysical Union, Fourth General Conference, Stockholm, 1930, 10 cents.

Annual Report of the Superintendent of the Geodetic Survey of Canada for the fiscal year ending March 31, 1918, 10 cents. The same for the year 1922, 10 cents.

Annual Reports of the Director of the Geodetic Survey of Canada for the fiscal years, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932; each 10 cents.

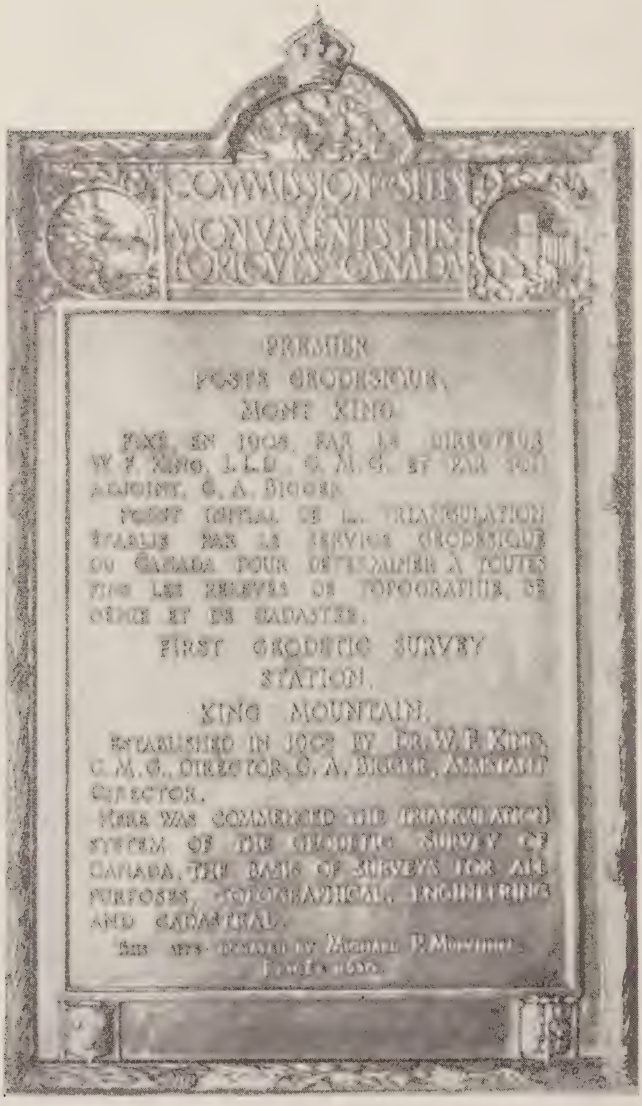
38—Precise Levelling on Vancouver Island, 10 cents.

Copies of the above publications may be obtained by applying to the Director of the Geodetic Survey of Canada, Department of the Interior, Ottawa.

Where name and number (or year) are omitted, the publication is not available for distribution.

Reqn. 5873

King Mountain Triangulation Station.



Tablet, King Mountain Triangulation Station.